

# **DUNE 35t Activity at BNL Status**

B. Kirby- June 17, 2015 - BNL DUNE Local  
Meeting

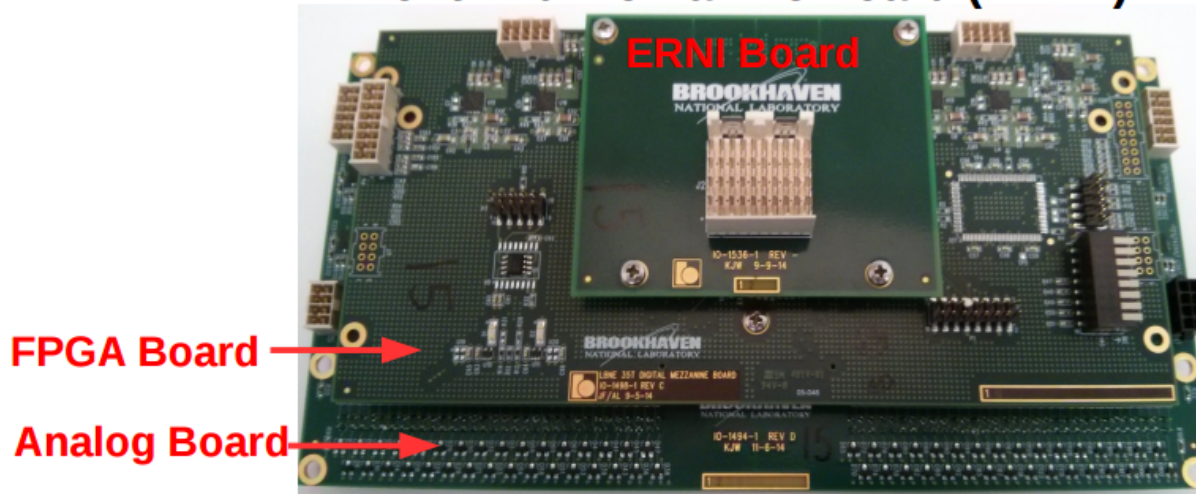
# The DUNE 35t Detector

- **BNL responsible for testing DUNE 35t electronics, support installation and commissioning**
  - Test board functionality at cryogenic temperature, measure performance
  - Work with instrumentation division to validate FEMBs and firmware
  - Develop calibration procedures
  - Integrate FEMB readout into 35t DAQ
  - Participate in electronics installation and commissioning
  - Contribute to electronics simulation in 35t code
- **Current activity focused on board validation, DAQ integration**
  - Delay in delivery board to Fermilab due to underestimate integration effort
  - Recent progress in DAQ integration, regular data-taking starting

# Reminder - 35t FEMBs

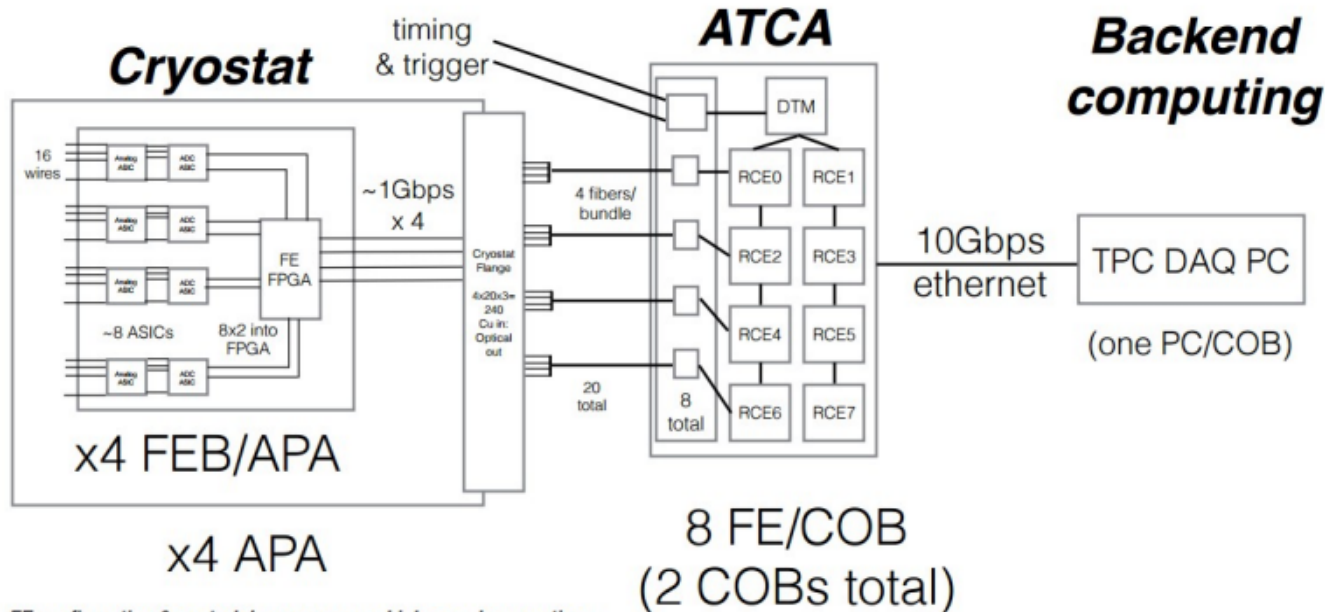
- 35t Front End Mother Boards (FEMBs) contain analog, FPGA and ERNI interface boards
- Full details in DocDb 10858, H. Chen
- Analog board: 8 FE ASICs + digitizing ADC ASICs, 128 channels
- FPGA board: Coordinates ASIC readout, streams data to backend
- ERNI connector board: 4 GB transceiver cables connector board
- **128:4 multiplexing**

Front End Mezzanine Board (FEMB)



# Reminder - 35t DAQ

- Ongoing Fermilab VST is a full end-to-end test of electronics chain
- FEMBs integrated into DAQ, configuration and data streaming works

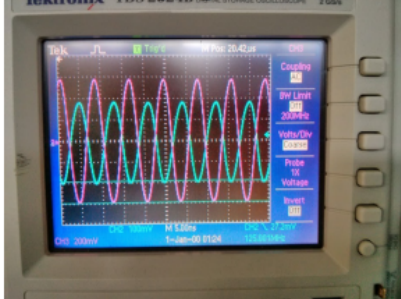


*FE configuration & control done over same high-speed connections as signal, with dedicated I2C links as a backup*

# 35t Production Board Validation Procedure

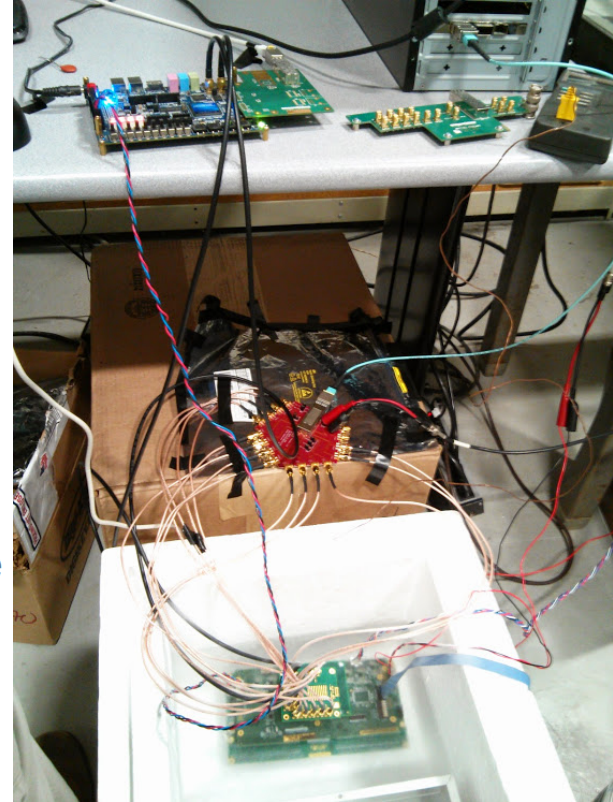
- 19 analog boards and 20 FPGA boards produced for 35t test
  - 16 required for full detector
- Extensive tests of FEMBs at room temperature and liquid nitrogen have been performed
- FEMBs validated in sequential tests:
  - On-board oscillator cryogenic screening prior to assembly
  - Post-assembly room temperature functionality test
  - Cryogenic functionality and performance validation
  - Final validation data-taking after cryogenic testing

## Pre-Assembly On-board Oscillator Cryogenic Screening



Pre-screen off-the-shelf on-board oscillators for correct output frequency in liquid nitrogen before assembled on production FEMBs  
**Reduce ambiguity in subsequent test stages**

## 35t FEMB Tested in Liquid Nitrogen



# Cryogenic Testing Status

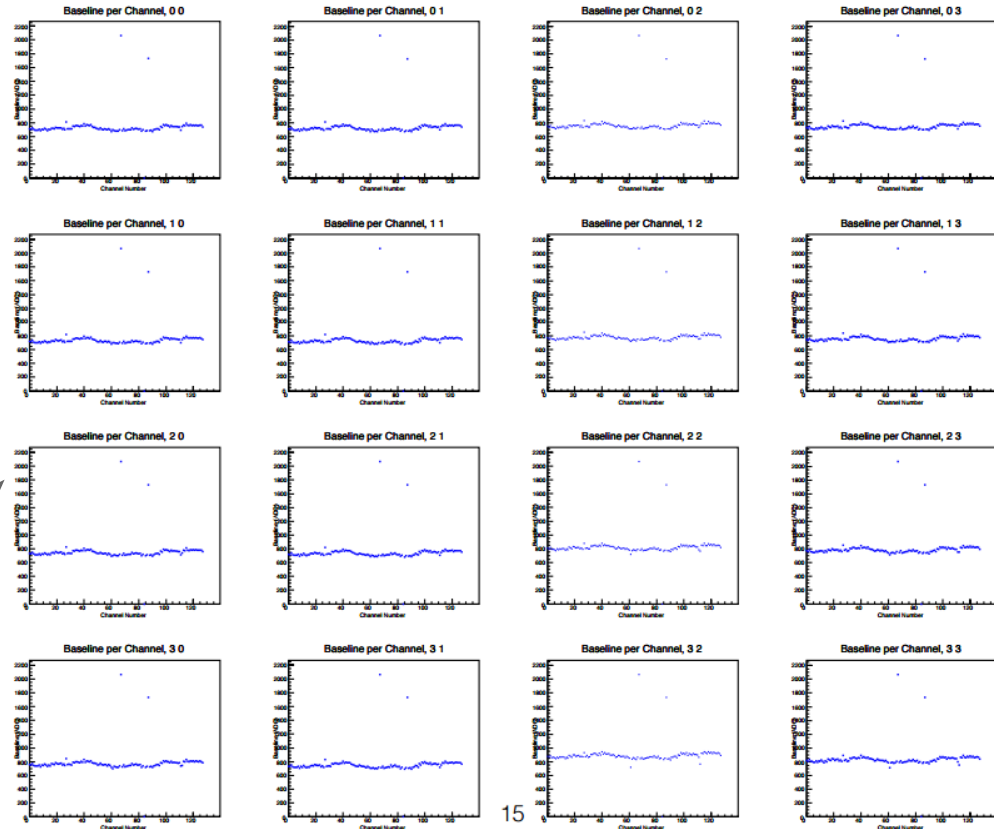
- Require minimum of 16 FEMBs (FPGA + analog boards) for 35t
- All FEMBs pass room temperature functionality tests
- Currently 14 FEMBs pass cryogenic testing
  - 16 out of 20 FPGA boards pass as of June 17
  - 14 out of 18 analog boards pass as of June 17
    - 4 analog boards have at least 1 ASIC with decreased performance in LN2, replacing ASIC generally resolves this
- General comments on cryogenic testing to date:
  - 49 cryogenic tests performed (original plan was 1 test for each board)
  - 15 FE ASICs replaced, 2 ADC ASICs

# Final Validation

- After board passes cryogenic testing, perform a set of validation data runs
- Measure baseline, noise, gain for every FEMB channel on multiple FE-ASIC configurations
- Check for board damage from cryogenic testing
  - **No damage detected to date**

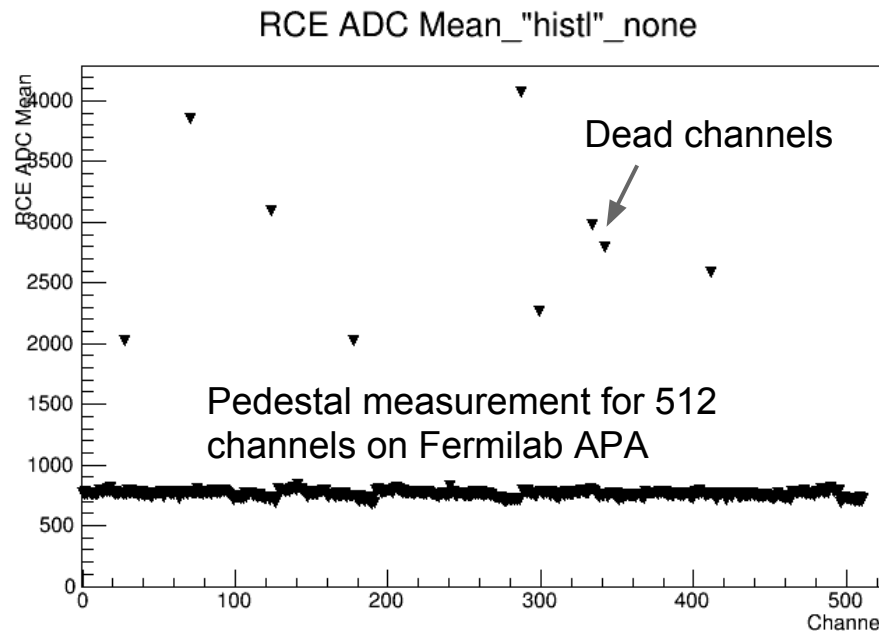
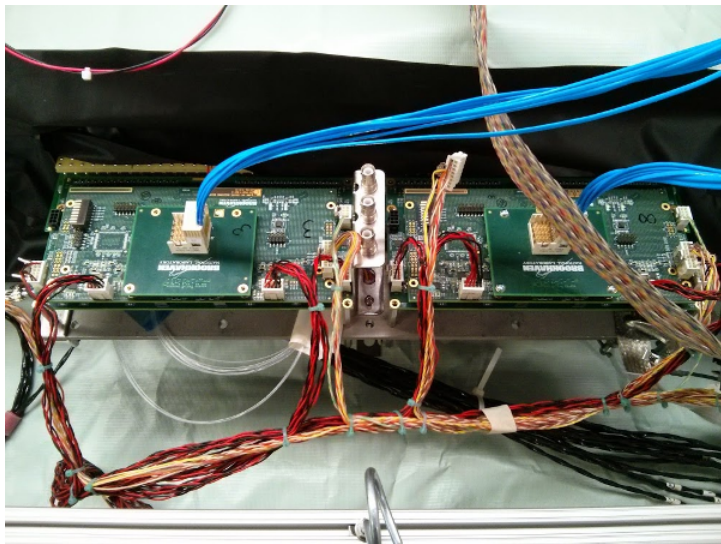
Calibration constants measured for multiple FE-ASIC configurations  
Significant amount of validation and calibration data recorded

## Validation Data for FEMB13 Baseline - low Baseline (200 mV)





# DAQ Integration



- 4 validated FEMBs installed on APA at Fermilab, integrated into 35t DAQ
- A few integration issues were discovered and resolved
  - Highlighted the need to establish integration test stand at BNL
- Regular data-taking underway, calibration pulser tests starting imminently



# Summary

- 35t FEMB validation nearly complete, installation underway
  - Final boards will be shipped to Fermilab by next week
- Full readout chain being tested at Fermilab
  - FEMB readout successfully integrated into 35t readout
  - Moving into APA pre-installation “check-out” imminently, will try to install as quickly as possible
  - BNL group responsible for several commissioning tasks and in-situ calibration, support and debug FEMB readout
- Many lessons learned from FEMB validation, compiling into a report
  - Extensive validation process provides confidence that validated FEMBs will work correctly in 35t detector